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A NOVEL SYSTEM FOR LOSSLESS MODIFIED COMPRESSION ON MEDICAL APPLICATION ON DICOM CT IMAGES

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ABSTRACT

In recent days, Digital Imaging and Communication in Medicine (DICOM) is widely used for distribution, storage and viewing of medical images from different modalities. Image compression is the major entities of communication and storage system which is capable of reducing the data redundancy and crippling disadvantages of data transmission and image storage. Medical image compression is necessary for huge database storage in Medical Centre and medical data transfer for the purpose of diagnosis. Wavelet transforms (DWT), discrete cosine transforms (DCT), Run Length Encoding Lossless compression technique presently are the most usefully and wider accepted approach for the purpose of compression. In this paper, we present a new DICOM based lossless image compression method based on discrete wavelet transform. In the proposed method, each DICOM image stored in the data set is compressed on the basis of horizontally, vertically and diagonally compression and further we report results from our comparative study of all the DICOM images in the data set using two measures namely PSNR and RMSE. This thesis is presenting the performance comparison between input image (without compression) and after compression results for each images in the data set using DWT method. The performance of these methods for image compression has been verified via computer simulations using MATLAB.

KEYWORDS: Medical Images, DICOM (Digital Imaging and Communication in Medicine), HAAR Wavelet, PSNR, RMSE, Compression

INTRODUCTION

With advancement of communication technology, digital images becomes very vital for information transmission and to cop up with this high speed transmission of image; efficient image storage and efficient image compression technique is very important. [2] The study of all compression techniques are important, different techniques use variety of medical images like MRI and X-RAY. We used the word DICOM (Digital Imaging Communication in Medicine) is used for storing transmitting and viewing of medical images. As compression techniques are very helpful in transmission and mass storage Many lossless compression techniques are used like Huffman coding, Run length, Arithmetic coding and Discrete wavelet transform are there that are providing better results. Wavelet based compression techniques reached to high potential because they provide exceptional image quality at high compression rate. In this paper dwt technique will be discussed which is based on sub-band coding in this a time scale representation of digital signal is obtained using different filtering techniques. [5]

LOSSLESS COMPRESSION TECHNIQUES

In lossless compression, the reconstructed image after compression is numerically identical to the original image.

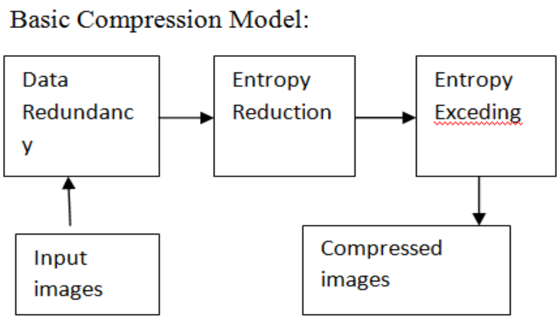


Figure 1: Compression Model

Lossless Coding Techniques

- Run length encoding
- Huffman encoding
- Arithmetic encoding
- LZW coding

Run length encoding: It includes sequence of same symbols called runs which are replaced by shorter symbols. It is applied to the images in order to get a set of data values, called as post processing steps.

Huffman encoding: It was developed by David Huffman for removing coding redundancy. The pixels in the image are treated as symbols. The symbols which occur more frequently are assigned a smaller number of bits while the symbols that occur less frequently are assigned relatively larger number of bits. It is a prefix code.

Arithmetic encodin**g:** It is similar to Huffman coding but Huffman coding treat every symbol separately and assigned codes to them, in arithmetic coding whole data sequence is replaced with single code.

LZW Coding: It is known as Lempel–Ziv-Welch Coding. Based on storing frequently occurring sequences of symbols in dictionaries. Theses frequently occurring sequences in the original data are represented by just their indices into the dictionaries. [3][4]

DICOM IMAGES

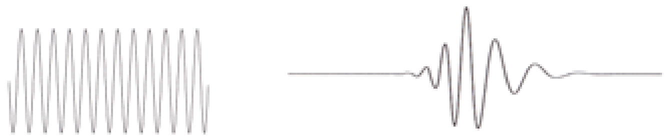
DICOM (digital images communication in medicines) is used for handling, storing, and transmitting information in medical imaging. The communication protocol is an application that uses TCP/IP model for interaction between two systems. It has been Accepted by various hospitals and providing a benefit to dentists' and doctors' offices. DICOM is the third version of a standard developed by American College of Radiology (ACR) and NEMA. In the beginning of the 1980s it was almost impossible for anyone other than manufacturers of CT or MR imaging Devices to decode the images that the machines generated. Radiologists wanted to use the images for dose-planning for radiation therapy. [9]

WAVELET TRANFORM

The wavelet transform (WT) has gained widespread acceptance in signal processing and image compression. Because of their inherent multi-resolution nature, wavelet-coding schemes are especially suitable for applications where scalability and tolerable degradation are important. [1] It performs multi-resolution image analysis which represents image at different resolution levels. It depicts an image as a sum of wavelet functions with different locations and scalar.

Decomposition of image into wavelets include pair of waveforms, one to represent the higher frequencies functions), one for low frequencies or smooth part s of an image (scaling function). [7]

$$F_j + 1(t) = f_j(t) + d_j(t)$$



(a) (b)

Figure 2: Demonstration of (a) A Wave and (b) A Wavelet

Discrete Wavelet Transform

The Discrete Wavelet Transform (DWT), is totally based on sub-band coding is discovered to gain a fast computation of Wavelet Transform. It is easy to implement and reduces the computation time and resources required. Wavelet transform decomposes a signal into a set of basic functions. These basis functions are called *wavelets. [6]* Wavelets are obtained from a single prototype wavelet *y(t)* called mother *wavelet* by *dilations* and *shifting:*

The image is firstly separated into blocks and each separate block is further passed through the two filters: scaling filter (basically a low pass filter) and wavelet filter (basically a high pass filter) and we found Four sub images after doing the first level of decomposition namely LL, LH, HL, and HH coefficients. The filter which is used for this transformation is a nonreversible filter. LL coefficient are passed to second level rest of the coefficient are discarded. The coefficients are then passed through a constant scaling factor to achieve the desired compression ratio[8]. Here, x[n] is the input signal, d[n] is the high frequency component, and a[n] is the low frequency component.

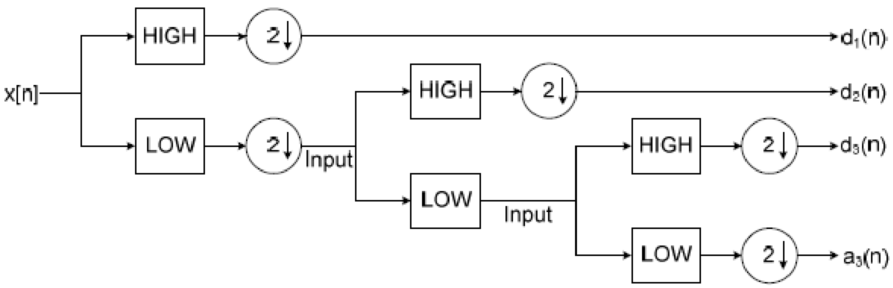


Figure 3: Block Diagram of the 2-Level DWT Scheme

PROPOSED WORK

In proposed method, a advanced approach to image compression technique is used that upgrade or improve its performance ,minimum data loss and also reconstructed that image, which is known as Discrete wavelet transform in dcm. We are using lossless compression technique, one of the method used is HAAR process. This process is a sequence of square shaped function that further forms wavelet and this wavelet is based on Fourier Transform. HAAR uses orthogonal combination on unit interval.

The technical, directional and anatomical aspects of an image are compressed using wavelets transformation of HAAR process. It states that:

- Image Instance of phenomenon E is accompanied by circumstance C.
- Let Dom be a domain of DICOM CT images represented as:

Dom= {Image1, Image2, Image3…..Image n}

- Let C be Circumstances associated with each instance of image:

C= {C1, C2, C3} ⟵ Image n

- Let E be phenomenon associated with each instance of image:

E= {E1, E2, E3} ⟵ Image n

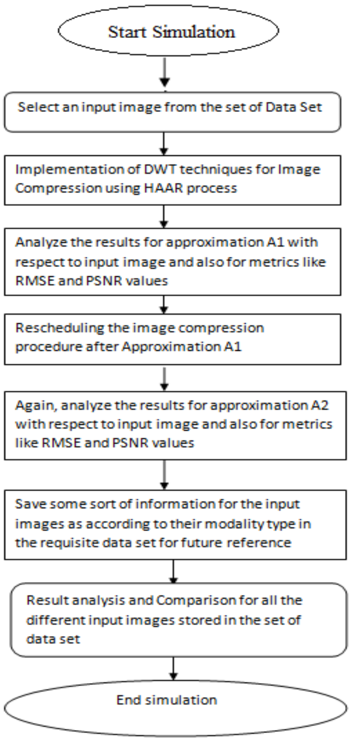


Figure 4: Flow Chart of Proposed Work

Development of Discrete Wavelet Coding Algorithm

- Development of a representative data set of DICOM CT images.
- Study of various linguistic Image Compression Techniques.
- Select an input image from the set of data set.
- Development of a storage schema which maps the discrete wavelets Transformation techniques for image compression using HAAR process.
- Development of an interface for storing the step wise procedure of compression for wavelet transformation.
- Analyze the results for approximation A1 with respect to input image for metrics like RMSE, PSNR.
- Rescheduling the image compression procedure after approximation A1
- Analyze the results for approximation A2 with respect to input image for requisite metrics.
- Save the some sort of information of input images as according to their modality in the dataset.
- Result analysis and comparison for all the inputs in the set of dataset

RESULTS AND DISCUSSIONS

In discrete images, HAAR wavelet approximation process can be describes as the best process, where to achieve significant compression an approximate image is passed as an Inputs to HAAR process & overall process measure the best compression for the DICOM CT images. The result for approximation 1 & approximation 2 can be analysed on the basis of input images given, where input images can be the set of images from data.

PSNR and RMSE are two key parameters which helps in measuring the performance of compressed images. For graphic tools, analysis, to examine a region of pixels, to detect & measure features, to do analysis of shapes and textures, for better visualization, to achieve standard algorithms for image processing and algorithm development, use of MATLAB Application helps in the overall process to achieve effective compressed image.

Performance Parameter

PSNR and RSME are the two effective parameters which helps in evaluation of performance of any medical DICOM CT images. To measure difference between the values predicted by a model or an estimator and the values actually observed, one of the key parameter RMSE (Root- Mean- Square Error) takes place.

$$RMSD = \sqrt{\frac{\sum_{t=1}^{n}(y_t - \hat{y}_t)^2}{n}}$$

PSNR is generally used to analyze quality of *image,* sound and video files in dB (decibels). In other words, *PSNR is* to measure the quality of reconstructed *images* that have been compressed

$$MSE = \frac{1}{m\,n}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2$$

Where, MSE represents the squared error of the images defined as,

$$PSNR = 10.\log_{10}\frac{(MAX_1^2)}{MSE}$$
$$= 20.\log_{10}\left(\frac{MAX_1}{\sqrt{MSE}}\right)$$
$$= 20.\log_{10}(MAX_1) - 10.\log_{10}(MSE)$$

Figure 5: Input DICOM Brain Image at Client Side

The above image is the input image which is undertaken for the simulation and after which we may proceed for further compression process to be carry out. This is the very first result of input image at client end.

Figure 6: Converted Input Image into Gray Scale

The above figure 6 depicts the very first step of image compression in which we first convert the taken input image into gray scale and other more properties like size and image contrast for poor and adjusted terms of nature of the image. This is the basic step of compression of image which is performed according to the need and performing nature of implementation of the requisite process.

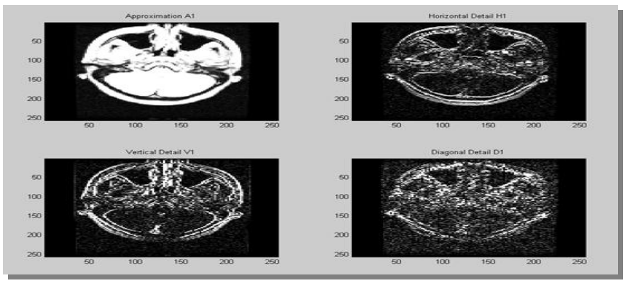


Figure 7: Results for Input Image after Approximation A1 (Decomposition Level First)

The above figure 7 signifies the result of first level decomposition of image by approximation A1. In this step, we find the results of compression according to their Horizontal detail compression termed as H1, vertical detail compression termed as V1 and diagonal detail compression termed as D1. From the analysis of above figure 7 we found that there is need to do some more decomposition for getting and comparing the valuable and reliable results.

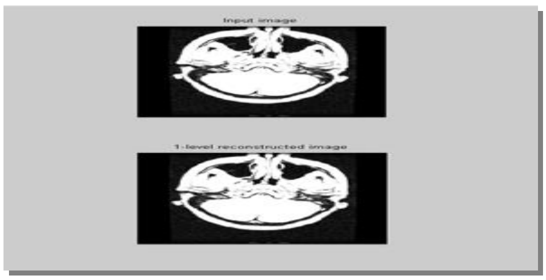


Figure 8: Decomposition Level-1 Reconstructed Image

The above figure 8 depicts the results of reconstructed image after first level decomposition in which we carry out compression of image diagonally, vertically and horizontal. For the sake of further compression at that time, it must require to reconstruct the image by applying inverse mechanism. From the results of reconstructed 1-level decomposition level we may now in position to do further decomposition of the input image.

CONCLUSIONS

In this paper, we have stressed towards the compression of DICOM images using DWT. The performance and comparison was made over each images stored in the set of data set of DICOM images. Here, we have taken two metrics namely PSNR and RMSE. The results clearly depicts that the value of PSNR for all the images stored in the set of dataset

is quiet high after compression in compare to the value of before compression which is good, reliable and scalable for data storage and removes the data redundancy. The performance of our proposed method of DWT using HAAR process is measured over various images and observed the results for both decomposition levels. The proposed algorithm scheme has given superior image compression results for DICOM images.

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